

Research Note

The Component Parasite Community of Three Sympatric Toad Species, *Bufo cognatus*, *Bufo debilis* (Bufonidae), and *Spea multiplicata* (Pelobatidae) from New Mexico

STEPHEN R. GOLDBERG,¹ CHARLES R. BURSEY,² AND IRMA RAMOS¹

¹ Department of Biology, Whittier College, Whittier, California 90608 and

² Department of Biology, Pennsylvania State University, Shenango Valley Campus, 147 Shenango Avenue, Sharon, Pennsylvania 16146, e-mail: cxb13@psuvm.psu.edu

ABSTRACT: The component parasite communities in 3 sympatric species of toads from New Mexico were examined. *Bufo cognatus* ($N = 36$) harbored the cestode *Distoichometra bufonis* and the nematodes *Aplectana itzacanensis*, *Rhabdias americanus*, and larvae of *Physaloptera* sp. *Bufo debilis* ($N = 49$) harbored *D. bufonis*, *A. incerta*, *A. itzacanensis*, *R. americanus*, and larvae of *Physaloptera* sp. *Spea multiplicata* ($N = 31$) harbored *D. bufonis*, *A. incerta*, *A. itzacanensis*, and larvae of *Physaloptera* sp. The highest prevalence (69%, 34/49) was recorded for *A. incerta* in *B. debilis*. The greatest mean intensities (20) were recorded for *A. incerta* in *B. debilis* and *R. americanus* in *B. cognatus*. New Mexico is a new locality record for each of these species of helminths. The helminth component communities are depauperate and conform to the pattern of isolationist communities. The helminth compound community for these sympatric species of toads encompasses 5 species.

KEY WORDS: helminth community, Cestoda, *Distoichometra bufonis*, Nematoda, *Aplectana incerta*, *Aplectana itzacanensis*, *Physaloptera* sp., *Rhabdias americanus*, Bufonidae, *Bufo cognatus*, *Bufo debilis*, Pelobatidae, *Spea multiplicata*.

Parasite community structure is hierarchical: a parasite infrapopulation represents all members of a single species of parasite within an individual host; a parasite infracommunity includes all of the infrapopulations within an individual host; a component parasite community represents all of the infracommunities within a given host population; and a compound parasite community consists of all the helminth infracommunities within a community of host species (Root, 1973; Esch et al., 1975; Bush and Holmes, 1986; Holmes and Price, 1986). Caswell (1978) and Hanski (1982) have introduced the concept of core and satellite species at the component community level; core species are those that occur with relatively high prevalences and intensities of infection, whereas satellite species occur with less prevalence and are relatively less numerous. Holmes and Price (1986) developed

a set of theoretical considerations that predict that helminth infracommunities span a continuum ranging from isolationist to interactive. Isolationist communities are predicted when the colonization abilities of parasites are limited; interactive communities are predicted when the colonization abilities of the parasites are high.

Using this approach, we examined the component parasite communities in 3 sympatric toad species. This system is particularly advantageous for the study of helminth community organization as the hosts are locally abundant, diminishing the risks of serious impact by sampling. The great plains toad, *Bufo cognatus* Say, 1823, has a geographic range extending from extreme southern Canada to San Luis Potosí, Mexico, from near sea level to 2,440 m; the green toad, *Bufo debilis* Girard, 1854, ranges from southeast Colorado and southwest Kansas to Zacatecas Mexico and southeast Arizona to east Texas from sea level to above 1830 m; and the New Mexico spadefoot, *Spea multiplicata* (Cope, 1863), ranges from southwest Utah and southern Colorado to Guerrero and Oaxaca, Mexico, and western Arizona to western Oklahoma and western Texas from near sea level to around 2,470 m (Stebbins, 1985). The purpose of this paper is to examine helminth species overlap in a community of sympatric hosts.

Thirty-six *B. cognatus* (mean snout–vent length [SVL] \pm SD = 57 mm \pm 14, range 35–85 mm); 49 *B. debilis* (SVL = 39 mm \pm 4, range 31–52 mm), and 31 *S. multiplicata* (SVL = 43 mm \pm 5, range 32–50 mm) were collected 11 km on the road to Corralitos Ranch off Interstate 10, Exit 127, ca. 3 km W Las Cruces, Doña Ana County, New Mexico (32°17'N, 107°00'W, elevation 1,350–1,400 m), 4–6 August 1992. All toads were deposited in the Natural History Museum of Los Angeles County (LACM): *B. debilis* (LACM

Table 1. Prevalence, intensity, and range of helminths from *Bufo cognatus*, *Bufo debilis*, and *Spea multiplicata* from New Mexico.

Parasite species	<i>Bufo cognatus</i>		<i>Bufo debilis</i>		<i>Spea multiplicata</i>	
	Prevalence	\bar{x} intensity (range)	Prevalence	\bar{x} intensity (range)	Prevalence	\bar{x} intensity (range)
Cestoidea						
<i>Distoichometra bufonis</i>	39%	4 (1–10)	51%	2 (1–11)	10%	2 (1–3)
Nematoda						
<i>Aplectana incerta</i>	—	—	69%	20 (1–68)	16%	4 (1–6)
<i>Aplectana itzocanensis</i>	50%	12 (1–69)	63%	9 (1–35)	39%	7 (1–31)
<i>Physaloptera</i> sp.	22%	3 (1–9)	2%	1	3%	8
<i>Rhabdias americanus</i>	14%	20 (1–67)	6%	2 (1–5)	—	—

140514–140562); *B. cognatus* (LACM 140563–140598); and *S. multiplicata* (LACM 140599–140629).

Toads were fixed in neutral-buffered 10% formalin. The body cavity was opened by a longitudinal incision from vent to throat and the gastrointestinal tract was removed by cutting across the anterior esophagus and rectum. The lungs, esophagus, stomach, small intestine, large intestine, and bladder of each toad were examined separately. Each helminth was removed and placed on a microscope slide in a drop of undiluted glycerol. A coverslip was added, and the slide was set aside until the helminth became transparent. Each helminth was identified using this glycerol wet-mount method. Representative cestodes were stained with hematoxylin and mounted in balsam for further examination.

One cestode, *Distoichometra bufonis* Dickey, 1921, and 4 nematodes, *Aplectana incerta* Caballero, 1949, *Aplectana itzocanensis* Bravo Hollis, 1943, *Rhabdias americanus* Baker, 1978, and third-stage *Physaloptera* sp. were found. Lesions or scars attributable to parasitic infection were not observed. Terminology use is in accordance with Margolis et al. (1982). Prevalence and mean intensity of infection varied across host species (Table 1). Selected intact specimens were placed in vials of 70% ethanol and deposited in the USNM Helminthological Collection, USDA, Beltsville, Maryland, U.S.A.: *B. cognatus*: *Distoichometra bufonis* (83295), *Aplectana itzocanensis* (83296), *Physaloptera* sp. (83294), *Rhabdias americanus* (83660); *B. debilis*: *D. bufonis* (83297), *A. incerta* (83298), *A. itzocanensis* (83299), *Physaloptera* sp. (83362), *Rhabdias americanus* (83361) and *S. multiplicata*: *D. bu-*

fonis (83302), *A. incerta* (83303), *A. itzocanensis* (83304), *Physaloptera* sp. (83301).

Twenty-eight of 36 (78%) *B. cognatus* harbored helminths: 6 of 7 males (86%), 11 of 15 females (73%), and 10 of 14 juveniles (71%). A total of 394 helminths were found: 54 *D. bufonis*, 216 *A. itzocanensis*, 25 third-stage *Physaloptera* sp. and 99 *R. americanus*. *Aplectana itzocanensis* had the highest prevalence (50%); *Rhabdias americanus* had the greatest mean intensity (20). There was no significant difference in prevalence of infection among male, female, and juvenile toads: *D. bufonis* (3, 5, and 6 infected male, female, and juvenile toads, respectively; chi-square = 0.14, 2 df, $P > 0.05$), *A. itzocanensis* (4, 8, and 6; chi-square = 0.16, 2 df, $P > 0.05$), *Physaloptera* sp. (2, 5, and 1; chi-square = 2.06, 2 df, $P > 0.05$), or *R. americanus* (1, 2, and 2; chi-square = 0, 2 df, $P > 0.05$). Of the infected toads, 15 were infected by a single species of helminth (6 with *D. bufonis*, 6 with *A. itzocanensis*, 2 with *Physaloptera* sp., and 1 with *R. americanus*), 9 were infected by 2 species (4 with *A. itzocanensis* and *Physaloptera* sp., 3 with *D. bufonis* and *A. itzocanensis*, 1 with *A. itzocanensis* and *R. americanus*, and 1 with *D. bufonis* and *Physaloptera* sp.), and 4 were infected by 3 species (3 with *D. bufonis*, *A. itzocanensis*, and *R. americanus*, 1 with *D. bufonis*, *A. itzocanensis*, and *Physaloptera* sp.). Mean intensity for total helminth load was 11 (1–43). There was no correlation between total number of helminths and SVL ($r = 0.6$).

Forty-eight of 49 (98%) *B. debilis* harbored helminths: 37 of 38 male toads (97%) and 11 of 11 females (100%). A total of 1,024 helminths were found: 57 *D. bufonis*, 674 *A. incerta*, 285 *A. itzocanensis*, 1 *Physaloptera* sp., and 7 *R.*

americanus. *Aplectana incerta* had the highest prevalence (69%) and greatest mean intensity (20). There was no significant difference in prevalence of infection between male and female toads: *D. bufonis* (18 males and 6 females infected; chi-square [Yate's correction] = 0.30, 1 df, $P > 0.05$), *A. incerta* (28 and 6; chi-square = 0.33, 1 df, $P > 0.05$), *A. itzocanensis* (23 and 6; chi-square = 0.05, 1 df, $P > 0.05$) and *R. americanus* (2 and 1; chi-square = 0.17, 1 df, $P > 0.05$); a single male was infected with *Physaloptera* sp. Of the infected toads, 14 were infected by a single species of helminth (7 with *A. incerta*, 4 with *A. itzocanensis*, and 3 with *D. bufonis*); 22 were infected by 2 species (9 with *A. incerta* and *A. itzocanensis*, 7 with *D. bufonis* and *A. incerta*, 4 with *D. bufonis* and *A. itzocanensis*, and 2 with *A. itzocanensis* and *R. americanus*); 12 were infected by 3 species (11 with *D. bufonis*, *A. incerta*, and *A. itzocanensis* and 1 with *D. bufonis*, *A. itzocanensis*, and *Physaloptera* sp.). There was no correlation between total number of helminths and SVL ($r = 0.27$). *Aplectana incerta* and *A. itzocanensis* cooccurred in 16 *B. debilis*; in 10 (63%) of these cooccurrences, *A. incerta* had the higher intensity.

Seventeen of 31 (55%) *S. multiplicata* harbored helminths: 5 of 10 males (50%) and 12 of 21 females (57%). A total of 115 helminths were found: 6 *D. bufonis*, 21 *A. incerta*, 80 *A. itzocanensis*, and 8 *Physaloptera* sp. *Aplectana itzocanensis* had the highest prevalence (39%) and mean intensity (7). There was no significant difference in prevalence between male and female toads: *D. bufonis* (1 male and 2 females infected; chi-square [Yate's correction] = 0.01, 1 df, $P > 0.05$), *A. incerta* (1 and 4; chi-square = 0.30, 1 df, $P > 0.05$), *A. itzocanensis* (3 and 9; chi-square = 0.21, 1 df, $P > 0.05$); a single male was infected by *Physaloptera* sp. Of the infected toads, 14 were infected by a single species of helminth (9 with *A. itzocanensis*, 3 with *A. incerta*, 1 with *Physaloptera* sp., and 1 with *D. bufonis*), 2 with 2 species (1 with *A. incerta* and *A. itzocanensis* and 1 with *D. bufonis* and *A. itzocanensis*), and 1 with 3 species (*D. bufonis*, *A. incerta*, and *A. itzocanensis*). There was no correlation between total number of helminths and SVL ($r = 0.11$). *Aplectana incerta* and *A. itzocanensis* cooccurred in 2 *S. multiplicata*.

None of the parasites found in this study were unique to *B. cognatus*, *B. debilis*, or *S. multiplicata*; however, *B. debilis* is a new host record for

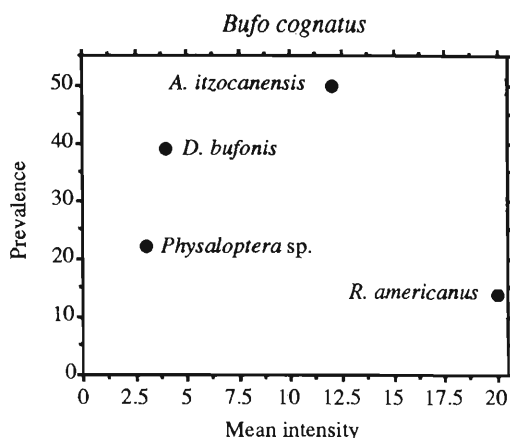


Figure 1. Scattergram of prevalence versus mean intensity of helminths from *Bufo cognatus*. Core species appears in the upper-right quadrant.

A. incerta, *A. itzocanensis*, *Physaloptera* sp., and *R. americanus*, and *S. multiplicata* is a new host record for *A. incerta* and *Physaloptera* sp. New Mexico is a new locality record for each of these species of helminths. In each host species, the composite helminth community is depauperate with more than 55% of the individual helminths belonging to a single species. The compound helminth community for these sympatric toads is limited to 5 species.

Because core species are defined as those species that occur with relatively high prevalence and mean intensity, whereas satellite species occur with less frequency and are relatively less numerous than core species (Caswell, 1978; Hanski, 1982), we constructed a scatter plot of prevalence and mean intensity in order to categorize members of the component parasite community (Figs. 1–3). As these plots give equal weight to prevalence and mean intensity, we would expect core species to appear in the upper-right quadrant of the graph and satellite species to appear in the other quadrants. Several authors (Bush and Holmes, 1986; Stock and Holmes, 1987; Kennedy and Bakke, 1989) consider core species as those that have prevalences higher than 70%. Roca and Hornero (1992) defined core species in depauperate reptile communities as those species with prevalences greater than 30%. For each host, we defined a single core species: *Aplectana itzocanensis* for *Bufo cognatus* and *Spea multiplicata*, and *A. incerta* for *B. debilis*.

Three species of *Aplectana* are known from

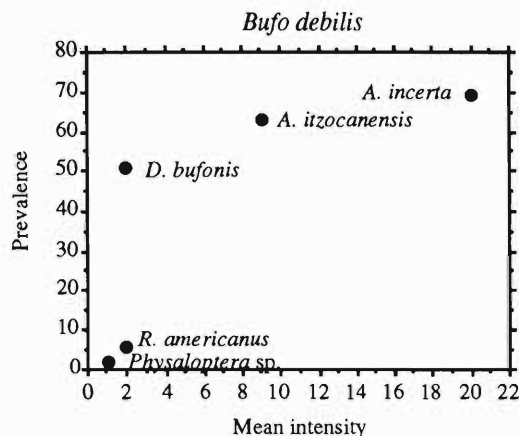


Figure 2. Scattergram of prevalence versus mean intensity of helminths from *Bufo debilis*. Core species appears in the upper-right quadrant.

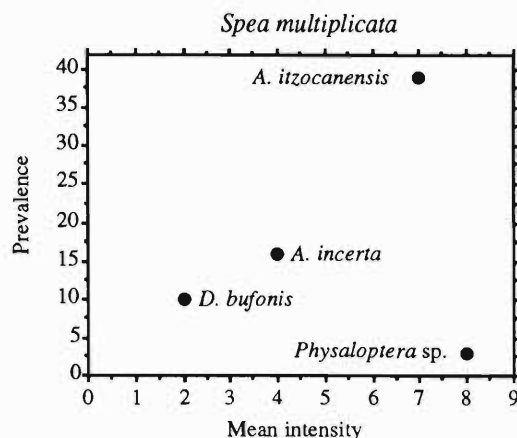


Figure 3. Scattergram of prevalence versus mean intensity of helminths from *Spea multiplicata*. Core species appears in the upper-right quadrant.

North America. *Aplectana incerta* was originally described by Caballero y C. (1949) from *Bufo marinus* from Chiapas, Mexico, and has been redescribed from type specimens by Baker (1985). It is also known from *Scaphiopus couchii* from Arizona (Goldberg and Bursey, 1991). *Aplectana itzocanensis* was originally described by Bravo H. (1943) from *Spea* (= *Scaphiopus*) *multiplicata* and *B. marinus* from Puebla, Mexico. It was also redescribed by Baker (1985) from *Bufo woodhousii woodhousii*. It has been reported in *B. marinus* from Costa Rica (Brenes and Bravo Hollis, 1959) and Veracruz, Mexico (Caballero Deloya, 1974), as well as *B. alvarius* and *B. cognatus* from Arizona (Goldberg and Bursey, 1991) and *S. couchii* from Arizona (Tinsley, 1990). The third North American species, *A. hoffmani*, originally described by Bravo H. (1943) from *S. multiplicata*, is considered by Baker (1985) to be synonymous with *A. itzocanensis*. Thus, the colonization abilities of species of *Aplectana* appear to be rather limited. Although the life histories of American species of *Aplectana* have not been studied, Chabaud and Brygoo (1958) studied *Aplectana courdurieri* and showed that infection in adult toads is acquired when larvae are swallowed by tadpoles and retained through metamorphosis or when larvae are accidentally swallowed by adult toads.

Of the satellite helminth species, infection by *Distoichometra bufonis* and *Physaloptera sp.* occurs through the ingestion of insects while *Rhabdias americanus* infects the host by skin penetration. *Rhabdias americanus* is known only from

species of *Bufo*; *Distoichometra bufonis* is known from species of *Bufo*, *Scaphiopus*, and *Spea* (see Baker, 1987). To our knowledge, no cases of parasitism of toads by adult physalopterans have been reported, although they are commonly found in reptiles, birds, and mammals (Anderson, 1992). Goldberg et al. (1993) listed herpetiles infected by larval physalopterans only (infection by adults is unknown in these species); *B. debilis* and *S. multiplicata* should be added to that list. Because development to adult stages does not occur and because these larvae do not encyst as would be expected in paratenic hosts, we consider infection by larval physalopterans to be incidental, a byproduct of prey ingestion, and unimportant in the study of helminth community dynamics of toads.

In conclusion, our results confirm that the helminth communities of the 3 toad species are depauperate and conform with the pattern of isolationist communities. We would predict that any other species of toad in this study area would harbor parasites from the compound community.

We thank Paul Hyder (New Mexico State University) for assistance in collection of specimens.

Literature Cited

- Anderson, R. C. 1992. Nematode Parasites of Vertebrates. Their Development and Transmission. CAB International, Wallingford, Oxon, U.K. 578 pp.
- Baker, M. R. 1985. Redescription of *Aplectana itzocanensis* and *A. incerta* (Nematoda: Cosmocer-

- cidae) from amphibians. *Transactions of the American Microscopical Society* 104:272–277.
- . 1987. Synopsis of the Nematoda parasitic in Amphibians and Reptiles. Occasional Papers in Biology. Memorial University of Newfoundland, St. John's, Newfoundland, Canada. 325 pp.
- Bravo-Hollis, M.** 1943. Dos nuevos nemátodos parásitos de anuros del Sur de Puebla. *Anales del Instituto de Biología Universidad Nacional de México* 14:69–78.
- Brenes, R. R., and M. Bravo Hollis.** 1959. Helminths of the República de Costa Rica. VIII. Nematoda 2. Algunos nemátodos de *Bufo marinus marinus* (L.) y algunas consideraciones sobre los géneros *Oxytomatum* y *Aplectana*. *Revista de Biología Tropical* 7:35–55.
- Bush, A. O., and J. C. Holmes.** 1986. Intestinal parasites of lesser scaup ducks: an interactive community. *Canadian Journal of Zoology* 64:142–152.
- Caballero y C. E.** 1949. Estudios helmintológicos de la región oncocercosa de México y de la República de Guatemala. Nematoda, 5 Parte. *Anales del Instituto de Biología Universidad Nacional de México, Series Zoología* 20:179–292.
- Caballero Deloya, J.** 1974. Estudio helmintológico de los animales silvestres de la estación de biología tropical "Los Tuxtlas," Veracruz. Nematoda 1. Algunos nemátodos parásitos de *Bufo horribilis* Wiegmann, 1833. *Anales del Instituto de Biología Universidad Nacional de México*, 45:45–50.
- Caswell, H.** 1978. Predator-mediated coexistence: a nonequilibrium model. *American Naturalist* 112:127–154.
- Chabaud, A. G., and E. R. Brygoo.** 1958. Description et cycle évolutif d'*Aplectana courdurieri* n. sp. (Nematoda, Cosmocercidae). *Memoires Institut Scientifique de Madagascar Series A. Biologie Animales* 12:159–176.
- Esch, G. W., J. W. Gibbons and J. E. Bourque.** 1975. An analysis of the relationship between stress and parasitism. *American Midland Naturalist* 93:339–353.
- Goldberg, S. R., and C. R. Bursey.** 1991. Helminths of three toads, *Bufo alvarius*, *Bufo cognatus* (Bufonidae), and *Scaphiopus couchii* (Pelobatidae), from Southern Arizona. *Journal of the Helminthological Society of Washington* 58:142–146.
- , ———, and **R. Tawil.** 1993. Gastrointestinal helminths of the western brush lizard, *Urosaurus graciosus graciosus* (Phrynosomatidae). *Bulletin of the Southern California Academy of Science* 92:43–51.
- Hanski, I.** 1982. Dynamics of regional distribution: the core and satellite species hypothesis. *Oikos* 38:210–221.
- Holmes, J. C., and P. W. Price.** 1986. Communities of parasites. Pages 187–213 in J. Kikkawa and D. J. Anderson, eds. *Community Ecology: Pattern and Process*. Blackwell Scientific Publications, Oxford.
- Kennedy, C. R., and T. A. Bakke.** 1989. Diversity patterns in helminth communities in common gulls, *Larus canus*. *Parasitology* 98:439–445.
- Margolis, L., G. W. Esch, J. C. Holmes, A. M. Kuris, and G. A. Schad.** 1982. The use of ecological terms in parasitology (report of an ad hoc committee of the American Society of Parasitologists). *Journal of Parasitology* 68:131–133.
- Roca, V., and M. J. Hornero.** 1992. A contribution to the knowledge of helminth communities of insular lizards. Pages 393–398 in Z. Korsós and I. Kiss, eds. *Proceedings of the 6th Ordinary General Meeting of the Societas Europaea Herpetologica*, Hungarian Natural History Museum, Budapest.
- Root, R. B.** 1973. Organization of a plant–arthropod association in simple and diverse habitats: the fauna of collards (*Brassica oleracea*). *Ecological Monographs* 43:95–124.
- Stebbins, R. C.** 1985. *A Field Guide to Western Reptiles and Amphibians*. Houghton Mifflin Company, Boston, Massachusetts. 336 pp.
- Stock, T. M., and J. C. Holmes.** 1987. Host specificity and exchange of intestinal helminths among four species of grebes (Podicipedidae). *Canadian Journal of Zoology* 65:669–676.
- Tinsley, R. C.** 1990. The influence of parasite infection on mating success in spadefoot toads, *Scaphiopus couchii*. *American Zoologist* 30:313–324.